Corrosion performance evaluation of Mn-V oxyanion sealed sulphuric acid anodized AA2024 by different electrochemical techniques

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ABSTRACT

Mn and V oxyanions were successfully incorporated into sulphuric acid anodized oxide layer developed on AA2024 as a sealing process. Cyclic Voltammetry (CV) was employed to understand the deposition mechanism of Mn and V oxyanions during sealing process. Different electrochemical techniques such as cyclic polarization, electrochemical noise (EN), and electrochemical impedance spectroscopy (EIS) were employed to study the corrosion performance of the developed coatings.

CV results showed the presence of cathodic peak potential (E_{pc}) at 0.36 V and -0.32 V for permanganate and vanadate solutions respectively. Both peaks indicated the multi electron transfer electrochemical reduction of permanganates and vanadates. X-ray photoelectron spectroscopy (XPS) studies carried out on the pore filled oxide layers also indicated the presence of +4 oxidation states of both Mn and V. Results obtained from cyclic polarization technique showed the initiation of pitting occurred at -0.6 V on both plain (PO) and Mn-V oxyanion sealed oxide layers (MnVO). Whereas passivation potential (Ep) observed at -0.35 V only in the case of sealed oxide layer. No change in the current density (60 μAcm^{-2}) value was observed when the potential scan was increased to 2000 mV with respect to OCP. This could be due to the effective barrier layer property of the sealed oxide layer. No sign of visual pits were observed on cyclic polarization tested sealed oxide layer surface. EN results showed the higher noise resistance (R_n) value for MnVO (1.7 $M\Omega.cm^2$) compared to PO (0.24 $M\Omega.cm^2$) after 1 h immersion in 3.5 % NaCl solution. Similarly, EIS results showed 4 times higher modulus of impedance value at 0.01 Hz for MnVO (1.2 $M\Omega.cm^2$) compared to PO (0.29 $M\Omega.cm^2$) 1 h immersion NaCl solution. As per the military specification (MIL-DTL-81706) the sealed oxide layer (MnVO) qualified 336 h of neutral salt spray test. But PO surface was completely corroded within 200 h of salt spray exposure.

Keywords: Anodization; Cyclic Voltammetry; XPS; Corrosion

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